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Universal Work Holder Arrangement

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Universal Work Holder Arrangement

Background of the Invention

FIELD OF THE INVENTION

This invention relates generally to arrangements for holding work pieces at predetermined or convenient orientations, and more particularly, to an arrangement that allows simultaneous locking in place and clamping of a work holder arrangement at a precise location and orientation, and with multiple degrees of freedom with infinite resolution.

DESCRIPTION OF THE RELATED ART

Support arms for work holder arrangements are used in the prior art in various ways, such as for preparing sheet metal parts for assembly or further production. Often, such arrangements are employed with a holding arrangement that includes a suction cup, and are used to carry articles from one production process to another, or to hold the articles during processing.

It is desired to provide a mounting bracket, or arm, that affords quick orientation and clamping of the bracket into a desired position, while also permitting infinite resolution over multiple degrees of freedom. Some prior art work holder arrangements achieve rapid clamping and setting with a single fastener. These known brackets, however, achieve the clamping convenience at the expense of degrees for freedom. For example, a known bracket that clamps and sets with a single fastener provides neither axial extension of the bracket nor rotational positioning about the axis. This known bracket, therefore, is not universal.

Similarly, a further known bracket that has endeavored to achieve the capacity for rotational positioning about the axis requires that fixation be effected only at predetermined increments of rotation. This known arrangement does not provide infinite rotational placement resolution, and provides no axial extension whatsoever.

It is, therefore, an object of this invention to provide a mounting bracket arrangement for a work piece in process that provides rotational and axial placement about the bracket axis.

It is another object of this invention to provide a mounting bracket arrangement for a work piece in process that provides infinite placement resolution in rotational and axial placement of the work piece with respect to the bracket axis.

It is also an object of this invention to provide a mounting bracket arrangement for a work piece in process that provides up to four degrees of freedom of placement of the workpiece with respect to a mounting structure.

Summary of the Invention

The foregoing and other objects are achieved by this invention which provides, in accordance with a first apparatus aspect thereof, a work holder arrangement for supporting a work article at a desired orientation with respect to a support structure. The work holder arrangement is provided with a first clamp member for coupling with the support structure, the first clamp member having clamped and unclamped states. There is additionally a second clamp member for coupling with the work article, the second clamp member having clamped and unclamped states. A tube portion is coupled to a selected one of the first and second clamp members, and a shaft portion is coupled to the other of the first and second clamp members. The shaft portion is accommodated coaxially within the tube portion. Additionally, there is provided an expansion portion arranged coaxially with the shaft portion within the tube portion. The invention further is provided with an elongated member for engaging with the expansion portion and for applying an axial force thereto. Thus, upon the application of the axial force, the expansion portion is urged transaxially against an interior surface of the tube portion, and the selected one of the first and second clamp members simultaneously is urged into the clamped state.

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In one embodiment of the invention, the expansion portion is provided with a transverse ramp portion, and the shaft portion is terminated at an end portion thereof distal from the selected one of the first and second clamp members with a corresponding transverse ramp portion. In this manner, the transverse ramp portion of the expansion portion and the corresponding transverse ramp portion of the end portion of the shaft portion are arranged to communicate with each other. The expansion portion is engaged with the elongated member, and the axial force applied thereto is responsive to a displacement of the elongated member with respect to the expansion portion. Further in accordance with this embodiment of the invention, the communication between the transverse ramp portion of the expansion portion and the corresponding transverse ramp portion of the end portion of the shaft portion precludes rotation of the expansion portion as the elongated member is rotated.

Preferably, the shaft portion has a longitudinal bore therethrough for accommodating the elongated member. The longitudinal bore is axially arranged and dimensioned to accommodate a transaxial displacement of the elongated member, which occurs when the expansion portion is urged along the transverse ramp portion. In other embodiments, however, the elongated member is itself transaxially deformed, or flexed, to accommodate the transaxial displacement of the expansion portion as it is urged along the transverse ramp portion.

In a further embodiment of the invention, the shaft portion and the tube portion each have a circular cross-sectional configuration, whereby the expansion portion can be urged transaxially against an interior surface of the tube portion to fix the shaft portion at any axial location within the tube portion within a predetermined limit and at any rotational orientation between the shaft and tube portions. That is, the axial location of the shaft portion within the tube portion is adjustable with infinite resolution, as is the rotational orientation between these two portions.

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In a practical application of the invention, the support structure is in the form of a support bar having a predetermined cross-sectional configuration. The first clamp member is configured to be rotatable about support bar, and slidable axially therealong, when the first clamp member is in the unclamped state. It is fixed axially and rotationally thereto when the first clamp member is in the clamped state.

In a still further embodiment of the invention, there is additionally provided a work article engagement arrangement having a predetermined configuration, and the second clamp member is correspondingly configured. The work article engagement arrangement is angularly displaceable when the second clamp member is in the unclamped state, and fixed angularly with respect thereto when the second clamp member is in the clamped state. In a practical embodiment, the work article engagement arrangement has a substantially spherical configuration and the second clamp member is correspondingly configured to have a concave configuration. The work article engagement arrangement in this embodiment is displaceable angularly with infinite resolution over a conical region. Alternatively, the work article engagement arrangement has a substantially cylindrical or somewhat concave (or apple-core-like) configuration and the second clamp member is correspondingly configured to have a substantially cylindrical internal configuration. In this substantially cylindrical embodiment of the invention, however, the work article engagement arrangement is not displaceable angularly.

In a highly advantageous embodiment of the invention, the first clamp member and the shaft portion are integrally formed with each other. The expansion portion has a cross-sectional configuration that corresponds to the cross-sectional configuration of the shaft portion. Similarly,

in this advantageous embodiment, the second clamp member and the tube portion are integrally formed with each other.

The axial force applied by the elongated member urges the first clamp portion and the expansion portion toward each other.

In accordance with a further apparatus aspect of the invention, there is provided a work holder support arm for supporting a work article at a desired orientation with respect to a support structure. The work holder arrangement is provided with a first clamp member having clamped and unclamped states for coupling with the support structure. The first clamp member has an opening therethrough for accommodating the support structure, and through-hole arranged transverse to the opening. A shaft portion is coupled to the first clamp member, the shaft portion having a longitudinal bore therethrough arranged to be axially in registration with the through-hole of the first clamp member. Additionally, there is provided a second clamp member for coupling with the work article, the second clamp member having clamped and unclamped states. A tube portion is coupled to the second clamp member for accommodating telescopically therewithin the first shaft portion. An expansion portion is arranged coaxially with the shaft portion within the tube portion, and is provided with a threaded section. An elongated member with a threaded portion for engaging with the threaded section of the expansion portion is provided for applying an axial force thereto. Upon the application of the axial force, the expansion portion is urged transaxially against an interior surface of the tube portion, and simultaneously the selected one of the first and second clamp members is urged into the clamped state.

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In one embodiment of this further aspect of the invention, the first clamp member and the shaft portion are integrally formed. Similarly, the second clamp member and the tube portion are integrally formed.

In a preferred embodiment, the expansion portion and the shaft portion have corresponding transverse ramps arranged to communicate with each other, whereby upon the application of the axial force, the expansion portion is urged along the transverse ramp of the shaft portion and substantially radially against an interior surface of the tube portion

As previously noted, a work article engagement arrangement has a predetermined configuration, and the second clamp member is correspondingly configured. Thus, the work article engagement arrangement is angularly displaceable when the second clamp member is in the unclamped state, and fixed angularly with respect thereto when the second clamp member is in the clamped state. The work article engagement arrangement is, in this embodiment, displaceable with infinite resolution over a conical region.

Brief Description of the Drawing

Comprehension of the invention is facilitated by reading the following detailed description, in conjunction with the annexed drawing, in which:

Fig. 1 is a plan view of a specific illustrative embodiment of the invention in the form of a work holder bracket;

Fig. 2 is a plan view of the mounting portion of the work holder bracket of Fig. 1 showing ramp portions that enable fixation thereof with respect to the other portion by means of transaxial displacement of an expansion portion; and

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Fig. 3 is a side view of the embodiment of Fig. 1, further showing the arrangement by which an additional rotational and angular degree of placement freedom of the work piece is achieved.

Detailed Description

Fig. 1 is a plan view of a specific illustrative embodiment of the invention in the form of a work holder bracket 10. Work holder bracket 10 is formed of two major components, a shaft clamp that is generally designated as 11 and shown partially in phantom, and a tube clamp that is generally designated as 12.

Tube clamp 12, in this specific illustrative embodiment of the invention, has a tube portion 14 that has a first clamp subportion 15 installed thereon. In this embodiment, first clamp subportion 15 is integrally formed with tube portion 14. A second clamp subportion 16 is pivotally coupled at pivot 18 to first clamp subportion 15, and is forcefully urged thereto to effect a clamping by operation of a fastener 19. Other arrangements for effecting the clamping, such as toggle latches (not shown), can be used in the implementation of the invention.

Fig. 2 is a plan view of the mounting portion of the work holder bracket 10 of Fig. 1 showing shaft clamp 11 in greater detail. As shown, shaft clamp 11 has a clamp portion 20 having an aperture 21 therethrough. This aperture, in the practice of the invention, will accommodate a mounting bar (not shown) associated with a mounting structure (not shown). Clamp portion 20 appears to wrap around aperture 21 so as to have two leg portions 24 and 25. A further aperture 26 is arranged at the end of clamp portion 20, and directed in a direction orthogonal to aperture 21.

Leg portion 24 is coupled to a shaft portion 27. In a preferred embodiment, these elements are fixed to one another by integral formation, weldment (not shown), threaded coupling (not shown),

or otherwise. Shaft portion 27 has an axial bore 28 therethrough that is in axial registration with aperture 26 that begins on leg portion 25.

There is additionally shown in this figure an expansion portion 30 having an internally threaded portion 31. Expansion portion 30 has a transaxial ramp portion 34 that is arranged to communicate with a corresponding ramp portion 35 at the end of tube portion 27 distal from clamp portion 20. An elongated member 37 having a head 38 and a distal threaded portion 39 is configured to be accommodated into aperture 26 and to extend along axial bore 28 of tube portion 27. Threaded portion 39 of the elongated member is configured to engage threadedly with internally threaded portion 31 of expansion portion 30. Thus, as elongated member 37 is rotated in a tightening direction, expansion portion 30 is urged transaxially along the interface of ramp portions 34 and 35, placing a radial force against the inner surface of tube portion 14. Thus, the respective ramp portions enable fixation of the shaft portion within the tube portion at any axial location, within the predetermined limits of their respective lengths, and at any rotational orientation with respect thereto. Infinite placement resolution is thereby achieved.

Rotation of expansion portion 30 with the rotation of elongated member 37 is precluded by the interface of ramp portion 34 and 35. Also, it is seen that as expansion portion 30 is urged transaxially along the ramp portions, elongated member 37 is similarly transaxially displaced. Thus, axial bore 28 of shaft portion 27 must be configured with a diameter sufficient to accommodate the transaxial displacement of the elongated member.

Fig. 3 is a side view of the embodiment of Fig. 1, further showing the arrangement by which an additional rotational and angular degree of placement freedom of the work piece is achieved. Elements of structure that previously have been discussed are similarly designated. In some

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embodiments of the invention, a substantially spherical work holder element 40 is provided, having a work holder shaft 41 coupled thereto. First and second subclamp portions 15 and 16 (not specifically designated in this figure) have substantially spherically contoured internal surfaces 43 that will engage with the substantially spherical outer surface of work holder element 40. When work holder element 40 is engaged with contoured internal surfaces 43, work holder shaft 41 is rotationally movable, as well as angularly movable, as indicated by arrow 45. Tightening of fastener 19 will fix the work holder element at any desired orientation within the first and second subclamp portions 15 and 16, respectively.

The present invention therefore provides a mounting arrangement that affords the following degrees of freedom, each with infinite placement resolution:

- rotation of clamp portion 20 about the mounting bar (not shown);
- axial displacement between shaft clamp 11 and tube clamp12;and
- axial rotation between shaft clamp 11 and tube clamp12.

In some embodiments of the invention, there are provided the additional degrees of freedom with infinite resolution of:

- rotation of work holder shaft 41 with respect to shaft clamp 11 and tube clamp12; and
- angular displacement of work holder shaft 41 with respect to shaft clamp 11 and tube clamp12.

Although the invention has been described in terms of specific embodiments and applications, persons skilled in the art can, in light of this teaching, generate additional embodiments without exceeding the scope or departing from the spirit of the claimed invention. Accordingly, it is to be

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understood that the drawing and description in this disclosure are proffered to facilitate comprehension of the invention, and should not be construed to limit the scope thereof.